DRAFT - - FOR DISCUSSION PURPOSES ONLY - - DOES NOT REPRESENT MDH POLICY OR POSITION

Summary of studies which obtained and compared maternal serum, cord serum and breastmilk concentrations.

PFOS

Study	Design'	Maternal serum concen (ug/L)			Cord Blood Conc (ug/L)			Cord to Maternal serum concen ratio			Maternal serum concen (ug/L)			Infant Blood Conc (ug/L)			Infant to Maternal serum ratio			Breastmilk Concen (ug/L)			Breastmilk to Maternal serum concen ratio		
		Mean	Media n	95th% or Max	Mean	Median	95th% or Max	Mean	Media n	95th% or Max	Mean	Media n	95th% or Max	Mean	Media n	95th% or Max	Mean	Media n	95th% or Max	Mean	Media n	95th% or Max	Mean	Media n	95th% or Max
Cariou et al 2015	Maternal serum, cord serum and breast milk were obtained from 102 female volunteers hospitalized between June 2010 and Jan 2013 for planned caesarean delivery. Maternal blood and cord samples collected at time of delivery. Breast milk collected between 4th and 5th day after delivery. Final number of samples 100 for maternal serum, 106 cord serum (including 6 twin pairs)k, and 61 breast milk. Stjdy was not designed as an epi study but as an exploratory study to explore exposure trends to guide further studies.	3.67	3.065	24.5	1.28	1.115	8.04	0.349	0.364	0.328										0.04	<LOQ	0.376	0.011		0.015
Kim et al 2011	20 volunteers from Seoul donated maternal serum, umbilical cord serum, and breast milk in 2007. Maternal serum was obtained 1 day before delivery and umbilical cord serum was collected immediately after delivery. Breast milk was collected 3-10 days after delivery.	5.6		9.4	2.0		3.6	0.357		0.383										0.06		0.13	0.011		0.014
Haug et al 2011	41 female volunteers from Oslo, Norway area. Women donated a serum sample and ~half (N=19) provided a sample of breast milk. Serum samples were collect between Aug 2007 & May 2008. Breast milk samples were collected between Aug 2007 & Sept 2008. Authors - average breast milk concen were 1.4% of the corresponding serum concen																						0.014		
Liu et al 2011	Matched maternal serum, cord serum and breast milk samples were collected from 50 pairs of women and their newborns from Jiang Su province of China between June and July 2009. Cord blood samples collected immediately after delivery, maternal blood samples collected within first week after delivery, and breast milk samples within one week of delivery.	3.184	2.922	13.188	1.686	1.470	6.674	0.530	0.503	0.506										0.06	0.042	0.198	0.018	0.014	0.015
Fromme et al 2010	Maternal blood, cord blood, infant blood, & breast milk were collected druing Dec 2007-Oct 2009 in Munich, Germany. Study population - randomly selected females participating in a birthing class. Maternal blood collected @ 34-37th week of pregnancy, at delivery, & 6 months after birth. Cord blood collected @ delivery. Infant blood collected @~6 & ~19 months of age. Monthly breastmilk samples collected over a 5 month period after delivery. No sigificant differene in PFOS concentration seen over the 5 month collection period.	3.5	3.2	6.1	1.1	1	2.2	0.314	0.313	0.361	3.2	2.9	6.3	3.3	3.0	8.1	1.031	1.034	1.286		0.04	0.08		0.013	0.013
Monroy et al 2008	part of a larger ongoing study (Family Study). Maternal samples taken in 2nd trimester & again at delivery. Cord samples taken at delivery.	16.19	14.54		7.19	6.08		0.444	0.418																
Karrman et al 2007	Individual milk & serum samples from 12 women in Uppsala, Sweden, were collected in 2004. All samples were from primiparous women & were collected during the 3rd wk after delivery. [assume serum was collected at same time?]										20.7	18.7	48.0							0.2	0.166	0.47	0.010	0.009	0.010

Midasch et al 2007* (see below)	Plasma levels of 11 women a few hours prior to childbirth and corresponding cord plasma levels fo 11 neotnates. Samples collected March & April 2003. (Germany?)	12.1			7.2			0.595																	
Fei et al 2007	Danish Nat'l Cohort - pregnant women from March 1996 to Nov 2002. Maternal bld samples drawn twice: 1st and 2nd trimesters. Cord bld obtained shortly after birth.	29.9			11			0.368																	
Tittlemier et al 2004	Maternal & umbilical cord blood samples collected from 1994-2001 from individuals from various communities in the NW & Nunavut territories. Samples were pooled to form 10 maternal & 13 cord bld composites based on geographical region in which the donors resided & donor ethnicity.	36.9 pooled female adults			16.7 pooled			0.453																	
							N	**8**	**4**	**4**							**1**	**1**	**1**				**5**	**3**	**5**
							Min	**0.314**	**0.313**	**0.328**												**Min**	**0.010**	**0.009**	**0.010**
							Max	**0.595**	**0.503**	**0.506**												**Max**	**0.018**	**0.014**	**0.015**
							Ave	**0.426**	**0.399**	**0.394**							**1.031**	**1.034**	**1.286**			**Ave**	**0.013**	**0.012**	**0.013**
							Ave w/o pooled	**0.422**																	
							GeoMean	**0.417**	**0.393**	**0.389**												**GeoMean**	**0.012**	**0.012**	**0.013**
							GeoMean w/o pooled	**0.412**																	

*Midasch et al 2007

	Individual sample pairs	Mother	Neonate (cord)	Ratio
		13.6	7.3	0.537
		7.8	6	0.769
		13	6.9	0.531
		13.9	8.8	0.633
		11.2	7.8	0.696
		13.1	7.1	0.542
		9.7	7.8	0.804
		12.6	5.4	0.429
		16.4	9.5	0.579
		13.8	9.3	0.674
		8	3.3	0.413
	Mean	**12.1**	**7.2**	**0.601**

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PFOA

Study	Brief 'Study Description	Maternal serum concen (ug/L)			Cord Blood Conc (ug/L)			Cord to Maternal serum concen ratio			Maternal serum concen (ug/L)			Infant Blood Conc (ug/L)			Infant to Maternal serum ratio			Breastmilk Concen (ug/L)			Breastmilk to Maternal serum concen ratio		
		Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max	Mean	Median	95th% or Max
Cariou et al 2015	Maternal serum, cord serum and breast milk were obtained from 102 female volunteers hospitalized between June 2010 and Jan 2013 for planned caesarean delivery. Maternal blood and cord samples collected at time of delivery. Breast milk collected between 4th and 5th day after delivery. Final number of samples 100 for maternal serum, 106 cord serum (including 6 twin pairs)k, and 61 breast milk. Stjdy was not designed as an epi study but as an exploratory study to explore exposure trends to guide further studies.	1.22	1.045	7.31	0.919	0.86	7.06	0.75	0.82	0.97										0.041	<LOQ	0.308	0.034	NA	0.042
Kim et al 2011	20 volunteers from Seoul donated maternal serum, umbilical cord serum, and breast milk in 2007. Maternal serum was obtained 1 day before delivery and umbilical cord serum was collected immediately after delivery. Breast milk was collected 3-10 days after delivery.	1.6		3.2	1.1		2.7	0.69		0.84										0.041		0.077	0.026		0.024
Haug et al 2011	41 female volunteers from Oslo, Norway area. Women donated a serum sample and ~half (N=19) provided a sample of breast milk. Serum samples were collect between Aug 2007 & May 2008. Breast milk samples were collected between Aug 2007 & Sept 2008. Authors - average breast milk concen. were 3.8% of the corresponding serum concen.																						0.038		
Liu et al 2011	Matched maternal serum, cord serum and breast milk samples were collected from 50 pairs of women and their newborns from Jiang Su province of China between June and July 2009. Cord blood samples collected immediately after delivery, maternal blood samples collected within first week after delivery, and breast milk samples within one week of delivery.	1.655	1.264	5.879	1.5	1.115	6.442	0.91	0.88	1.10										0.181	0.121	1.44	0.109	0.096	0.245
Fromme et al 2010	Maternal blood, cord blood, infant blood, & breast milk were collected druing Dec 2007-Oct 2009 in Munich, Germany. Study population - randomly selected females participating in a birthing class. Maternal blood collected @ 34-37th week of pregnancy, at delivery, & 6 months after birth. Cord blood collected @ delivery. Infant blood collected @~6 & ~19 months of age. Monthly breastmilk samples collected over a 5 month period after delivery.	2.3	1.9	5.2	1.7	1.4	3.8	0.74	0.74	0.73	1.7	1.5	3.9	8.0	6.9	19.5	4.71	4.60	5.00	detected 2% of 201 samples range <0.15 - 0.25 ug/L		0.25			0.048
Monroy et al 2008	part of a larger ongoing study (Family Study). Maternal samples taken in 2nd trimester & again at delivery. Cord samples taken at delivery.	2.24	1.81		1.94	1.58		0.87	0.87																
Karrman et al 2007	Individual milk & serum samples from 12 women in Uppsala, Sweden, were collected in 2004. All samples were from primiparous women & were collected during the 3rd wk after delivery. [assume serum was collected at same time?]										3.8	3.8	5.3							NA (mean) NA (median) 0.492 (max) (N=1) [11 samples were >DL of 0.01 ug/L but blank level (0.209 ug/L) was >50% of detected concentrations	NA	0.492			
Midasch et al 2007* (see below)	Plasma levels of 11 women a few hours prior to childbirth and corresponding cord plasma levels fo 11 neotnates. Samples collected March & April 2003.	2.75			3.41			1.24																	

Fei et al 2007	Danish Nat'l Cohort - pregnant women from March 1996 to Nov 2002. Maternal bld samples drawn twice: 1st and 2nd trimesters. Cord bld obtained shortly after birth.	4.5			3.7			0.82																
Tittlemier et al 2004	Maternal & umbilical cord blood samples collected from 1994-2001 from individuals from various communities in the NW & Nunavut territories. Samples were pooled to form 10 maternal & 13 cord bld composites based on geographical region in which the donors resided & donor ethnicity.	2.2 (pooled)			3.4 (pooled)			1.55																
							N	**8**	**4**	**4**							**1**	**1**	**1**				**4**	**1**	**4**
							MIN	**0.688**	**0.737**	**0.731**												**MIN**	**0.026**	**0.096**	**0.024**
							MAX	**1.545**	**0.882**	**1.096**												**MAX**	**0.109**	**0.096**	**0.245**
							Ave	**0.945**	**0.829**	**0.909**							**4.706**	**4.600**	**5.000**			**AVE**	**0.052**	**0.096**	**0.090**
							Ave w/o poole	**0.859**																	
							GeoMean	**0.911**	**0.827**	**0.899**												**GEOMEAN**	**0.043**		**0.059**
							GeoMean w/o pooled	**0.845**																	

*Midasch et al 2007	Individual sample pairs	Mother	Neonate (cord)	Ratio
		2.4	3.4	1.42
		2.6	3.6	1.38
		3.4	3.8	1.12
		4	4.6	1.15
		2.4	3	1.25
		2.9	3.8	1.31
		2.1	4.1	1.95
		3.6	3.3	0.92
		2.8	3	1.07
		2.5	3.4	1.36
		1.5	1.5	1.00
	Mean	**2.75**	**3.41**	**1.27**